

AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the application.

LISTING OF CLAIMS

1. (cancelled).
2. (previously presented) The system as defined in claim 47 wherein the vessel is a pressure swing adsorber.
3. (original) The system as defined in claim 2 wherein the pressure swing adsorber comprises multiple, staged fixed beds.
4. (original) The system as defined in claim 2 wherein the pressure swing adsorber is a rotating vessel.
5. (original) The system as defined in claim 4 wherein the rotating vessel comprises:
 - an adsorption region;
 - a depressurization region;
 - a purge region; and
 - a pressurization region.

6. (original) The system as defined in claim 4 wherein the rotating vessel comprises two fixed valve faces.

7. (currently amended) The system as defined in claim ~~[[46]]~~49 which is a fuel cell system.

8. (previously presented) The system as defined in claim 47 wherein at least one of the first and second adsorbent is selected from the group consisting of 5A zeolite, 13X zeolite, and mixtures thereof.

9. (previously presented) The system as defined in claim 47 wherein at least one of the first and second adsorbent is selected from the group consisting of: oxides or salts of copper impregnated or exchanged on activated carbon, alumina, and zeolites; oxides or salts of silver impregnated or exchanged on activated carbon, alumina, and zeolites; oxides or salts of tin impregnated or exchanged on activated carbon, alumina, and zeolites; and mixtures thereof.

10. (previously presented) The system as defined in claim 47 wherein, upstream of the second carbon monoxide adsorbent, the vessel comprises a layer of a desiccant material.

11. (original) The system as defined in claim 10 wherein the desiccant material is selected from the group consisting of zeolite molecular sieves, activated alumina, silica gels, and mixtures thereof.

12-13. (cancelled)

14. (currently amended) The system of claim ~~[[46]]~~49 wherein the water gas shift reactor is a high temperature water gas shift reactor.

15. (cancelled).

16. (previously presented) The system as defined in claim 47 which further comprises an expander downstream of the vessel, and wherein the expander provides a purge gas to be fed back into the vessel.

17. (original) The system as defined in claim 16 which further comprises a fuel cell stack having an anode exhaust, the fuel cell stack disposed between the vessel and the expander, and wherein the expander expands the anode exhaust, the expanded anode exhaust providing the purge gas to be fed back into the vessel.

18. (original) The system as defined in claim 16 wherein the vessel is a rotating vessel, and wherein the expander is an isothermal expander adapted to provide electrical power for driving the rotating vessel.

19. (withdrawn) The system as defined in claim 2 wherein the hydrogen fuel cell system includes a low pressure steam stream, and wherein the steam stream provides a purge gas to be fed into the vessel.

20. (cancelled).

21. (currently amended) The system as defined in claim ~~[[20]]~~48 wherein the system further comprises an expander downstream of the vessel, and wherein the expander provides a purge gas to be fed back into the vessel.

22. (original) The system as defined in claim 21 wherein the system is a hydrogen fuel cell system further comprising a fuel cell stack having an anode exhaust, the fuel cell stack disposed between the vessel and the expander, and wherein the expander expands the anode exhaust, the expanded anode exhaust providing the purge gas to be fed back into the vessel.

23. (original) The system as defined in claim 21 wherein the expander is an isothermal expander adapted to provide electrical power for driving the rotating vessel.

24. (currently amended) The system as defined in claim ~~[[20]]~~48 wherein the system includes a low pressure steam stream, and wherein the steam stream provides a purge gas to be fed into the vessel.

25. (currently amended) The system as defined in claim ~~[[20]]~~48 wherein the ~~first~~ second adsorbent is further adapted to adsorb at least one of carbon dioxide and water from the hydrogen-rich gas stream.

26. (currently amended) The system as defined in claim 25 wherein the ~~first~~ second adsorbent is selected from the group consisting of 5A zeolite, 13X zeolite, and mixtures thereof.

27. (currently amended) The system as defined in claim ~~[[20]]~~48 wherein the first adsorbent is selected from the group consisting of oxides or salts of copper impregnated or exchanged on activated carbon, alumina, and zeolites; oxides or salts of silver impregnated or exchanged on activated carbon, alumina, and zeolites; oxides or salts of tin impregnated or exchanged on activated carbon, alumina, and zeolites; and mixtures thereof.

28. (currently amended) The system as defined in claim 27 wherein, upstream of the ~~first~~ second carbon monoxide adsorbent, the vessel comprises a layer of a desiccant material selected from the group consisting of zeolite molecular sieves, activated alumina, silica gels, and mixtures thereof.

29. (original) The system as defined in claim 7 wherein a preferential oxidizer (PROX) is eliminated from the hydrogen fuel cell system.

30. (original) The system as defined in claim 22 wherein a preferential oxidizer (PROX) is eliminated from the hydrogen fuel cell system.

31. (withdrawn) A method for removing carbon monoxide (CO) from a hydrogen-rich gas stream produced in a first reactor, the method comprising the step of passing the hydrogen-rich gas stream through a vessel which houses an adsorbent adapted to adsorb the carbon monoxide.

32. (withdrawn) The method as defined in claim 31 wherein the vessel is a rotating pressure swing adsorber.

33. (withdrawn) The method as defined in claim 32, further comprising the steps of:

pressurizing the vessel before the passing of the hydrogen-rich gas stream through the vessel;

depressurizing the vessel after the passing of the hydrogen-rich gas stream through the vessel; and

purging the vessel with a gas having a low carbon monoxide concentration.

34. (withdrawn) The method as defined in claim 31 wherein the hydrogen-rich gas stream is not passed through a preferential oxidizer (PROX).

35. (withdrawn) The method as defined in claim 31 wherein the adsorbent is a first adsorbent, and wherein the method further comprises the step of passing the hydrogen-rich gas stream through a second reactor which is a water gas shift reactor disposed between the first reactor and the vessel.

36. (withdrawn) The method of claim 35 wherein the water gas shift reactor includes a second adsorbent adapted to adsorb carbon monoxide.

37. (withdrawn) The method as defined in claim 36 wherein the second adsorbent is adapted to adsorb carbon monoxide at low temperatures and is adapted to desorb carbon monoxide at high temperatures.

38. (withdrawn) The method of claim 31 which in start-up mode comprises forming said hydrogen-rich stream by reacting a hydrocarbon fuel and air in the first reactor.

39. (withdrawn) The method of claim 38 which further includes a second reactor which is a water gas shift reactor disposed between the first reactor and the vessel.

40. (withdrawn) The method of claim 38 wherein after the start-up mode, steam is reacted along with the hydrocarbon fuel and air in the first reactor.

41. (withdrawn) A method for removing carbon monoxide from a hydrogen-rich gas stream produced in a first reactor, the method comprising the steps of:

passing the hydrogen-rich gas stream through a vessel which houses an adsorbent adapted to adsorb the carbon monoxide to provide a reduced CO content, wherein the vessel is a rotating pressure swing adsorber;

pressurizing the vessel before the passing of the hydrogen-rich gas stream through the vessel;

depressurizing the vessel after the passing of the hydrogen-rich gas stream through the vessel; and

purging the vessel with a gas having a low carbon monoxide concentration.

42. (withdrawn) The method as defined in claim 41 wherein the adsorbent is a first adsorbent, and wherein the method further comprises the step of passing the hydrogen-rich gas stream through a second reactor which is a high temperature water gas shift reactor disposed between the first reactor and the vessel, wherein the water gas shift reactor includes a second adsorbent adapted to adsorb carbon monoxide.

43. (withdrawn) The method as defined in claim 42 wherein the second adsorbent is adapted to adsorb carbon monoxide at low temperatures and is adapted to desorb carbon monoxide at high temperatures.

44. (withdrawn) The method as defined in claim 41 wherein the hydrogen-rich gas stream is not passed through a preferential oxidizer (PROX).

45. (withdrawn) The method of claim 41 which is conducted in a fuel cell system having a fuel cell stack, and wherein the hydrogen-rich gas stream having the reduced CO content is reacted in the fuel cell stack.

46. (cancelled).

47. (currently amended) The system of claim ~~[[46]]~~49 comprising a vessel downstream of said water-gas shift reactor, said vessel housing a second adsorbent adapted to adsorb the carbon monoxide.

48. (new) A system for removing carbon monoxide from a hydrogen-containing stream comprising:

a shift reactor including a reaction region having an inlet and an outlet, a water gas shift catalyst disposed within said reaction region and extending to said outlet and a first carbon monoxide adsorbent disposed within said region between said inlet and said outlet, wherein said shift reactor is adapted to receive a gas stream containing hydrogen and carbon monoxide, and wherein said first adsorbent is active to adsorb carbon monoxide at substantially ambient temperature and pressure conditions and to desorb carbon monoxide at normal shift reactor operating temperature and pressure conditions which are above said ambient temperature and pressure conditions; and

a rotating pressure swing adsorber vessel including a second carbon monoxide adsorbent in fluid communication with said outlet of said shift reactor, wherein said rotating pressure swing adsorber includes two fixed valve faces, an adsorption region, a depressurization region, a purge region, and a pressurization region.

49. (new) A system comprising a shift reactor including a reaction region having an inlet and an outlet, a water gas shift catalyst disposed within said reaction region and extending to said outlet and a carbon monoxide adsorbent disposed within said region between said inlet and said outlet, wherein said shift reactor is adapted to receive a gas stream containing hydrogen and carbon monoxide from an upstream reactor, and wherein said adsorbent is active to adsorb carbon monoxide at substantially ambient temperature and pressure conditions and to desorb carbon monoxide at normal shift reactor operating temperature and pressure conditions which are above said ambient temperature and pressure conditions.